Pedestrian-Oriented Street Intersection Density

This map portrays the degree of street connectivity for each U.S. Census block group, measured as pedestrian-oriented street intersections per square mile. Intersections that include major highways or other facilities that exclude pedestrian passage were not counted. To convert to intersections per square km, divide by 2.59.

Why is street intersection density important?

The design of a neighborhood's street network has a major impact on the ability of pedestrians and cyclists to travel efficiently to nearby destinations. The figure (right) shows two common street patterns found in U.S. neighborhoods. The gridded network on the left features high street connectivity and allows for more direct travel between destinations. The cul-de-sac neighborhood on the right features low street connectivity. Cul-de-sac residents are required to travel longer and more circuitous routes, including arterial roads, in order to reach most destinations.[1] Physical barriers such as railroad tracks, highways, lakes, and rivers can also reduce street connectivity.

Cul-de-sac neighborhoods are embedded in a network hierarchy in which strictly residential streets lead to collector streets where all retail and commercial activity occurs. These collector streets then lead to major arterials that connect to highways and other communities. Collector and arterial streets tend to be wide to allow vehicles to move faster and to handle the large traffic volumes channeled to them from smaller neighborhood streets. Wide streets are difficult and often dangerous for pedestrians and bicyclists to cross or to share with vehicles, especially if they lack sidewalks or crosswalks.[1] Such poor pedestrian environments discourage walking and bicycling, leading people to rely on driving, even for short trips. On the other hand, high connectivity street networks with short blocks can provide multiple routes for traffic, reducing the need for wide arterials.

Many communities created hierarchical street patterns in the belief that widening streets, eliminating intersections, and locating retail along arterials would improve traffic safety. However, traffic safety studies have failed to support this belief. In fact, some studies have found increased traffic collisions in neighborhoods with large arterial roadways. These designs are more dangerous for motorists as well as pedestrians and cyclists, when compared to pedestrian-oriented street networks, where frequent cross traffic encourages slower and more cautious driving.[2]

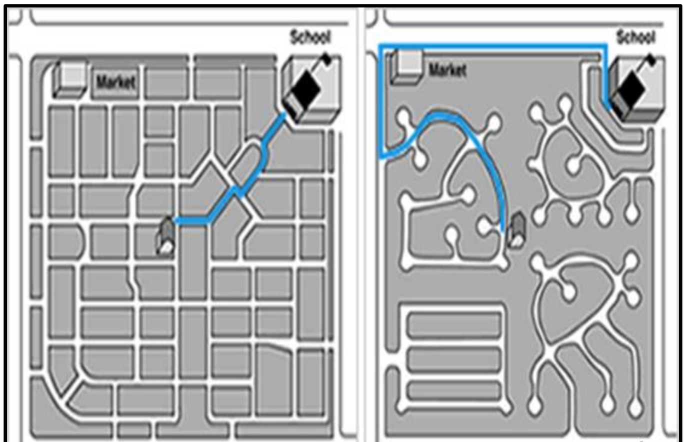

Figure: Oregon Neighborhood Street Design Guidelines[1]

Research indicates that higher street intersection density has environmental benefits. Numerous studies have shown that people living in neighborhoods with higher street intersection density tend to drive less and walk and take transit more. A recent study found that vehicle miles traveled are most strongly associated with accessibility to destinations and with street network design variables.[3] These attributes combined with a diversity of services tend to reduce the number of vehicle miles traveled. Results for walkability showed that the decision to walk was more often influenced by intersection density than street connectivity. The likelihood of transit use was most strongly associated with easy access to a transit stop. High intersection density and street connectivity served both transit riders and transit providers by increasing route choices.[3] In addition, higher street intersection density is associated with less per capita air pollution (e.g., nitrogen oxides, carbon dioxide, and ozone) from vehicle emissions, which benefits human health and the mitigation of climate change.[4]

How can I use this information?

Identifying neighborhoods with high street intersection density can be useful in a number of different urban planning contexts—particularly when considered alongside other built environment metrics such as residential density, employment density, and land use diversity. For instance, a transit planner determining station placement may wish to identify locations with high street intersection density to ensure residents will be able to easily access the station on foot or bike.

CONTINUED ON BACK ▶

Localities may also consider street intersection density when prioritizing neighborhood improvements such as sidewalks, street lighting, or bike lanes. Focusing such improvements in neighborhoods that are designed to better facilitate pedestrian and bicycle travel can help to ensure that new infrastructure gets the greatest amount of use.

Finally, Pedestrian-Oriented Street Intersection Density is also used as an input variable in transportation models that estimate trip generation, vehicle miles traveled, transit mode share, walking, and bicycle trips.

How were the data for this map created?

EPA derived this metric based on an analysis of NAVTEQ Streets data from 2011. The calculation weighted intersections based on the degree to which they promote connectivity. Three-way intersections provide reduced network connectivity compared to intersections with 4 or more legs. Therefore each 3-way intersection was counted as 0.6667 (instead of 1) to reflect this difference. Also, while intersection density is often used as an indicator of more walkable urban design, note that NAVTEQ provides no information regarding the presence or quality of sidewalks. For more information about this calculation, please see the design metric D3b in the Smart Location Database User Guide.

What are the limitations of these data?

The source data for this metric includes pedestrian walkways. As a result, street connectivity can be abnormally high in locations such as college campuses with a high density of walkways between buildings.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. This data layer is incorporated into a larger EPA data product called the Smart Location Database. The Smart Location Database is a nationwide geographic data resource for measuring location efficiency. Most attributes are available for every census block group in the United States.

Where can I get more information?

A selection of resources on the relationships among city planning, street network design, and environmental quality is listed below. More details about this metric are available in the Smart Location Database User Guide. In addition, EPA's Smart Growth Program provides tools, resources, and technical assistance to communities seeking to pursue neighborhood and street network design strategies that promote walkability to protect public health and the environment. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map layer list. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

Alexander Bell, Renaissance Planning Group, generated the data. The fact sheet was created by Kevin Ramsey, former EPA ORISE Fellow, Melissa Kramer, EPA Office of Sustainable Communities, and Sandra Bryce, Innovate!, Inc. The fact sheet was reviewed by Ted Cochin, EPA Office of Sustainable Communities.

Selected Publications

1. Stakeholder Design Team. 2000. Neighborhood street design guidelines: An Oregon guide for reducing street widths. Transportation and Growth Management Program, Oregon Department of Transportation and Oregon Department of Land Conservation and Development, Salem, Oregon. 30 p.

2. Dumbaugh, E., and W. Li. 2010. Designing for the safety of pedestrians, cyclists, and motorists in urban environments. *Journal of the American Planning Association* **77**:69–88.

3. Cervero, R., and J. Murakami. 2010. Effects of built environments on vehicle miles traveled: Evidence from 370 U.S. metropolitan areas. *Environment and Planning A 42*(2):400–418.

4. Frank, L. 2005. A study of land use, transportation, air quality, and health in King County, Washington: Executive Summary. Accessed 8-14.

Ewing, R., and R. Cervero. 2010. Travel and the built environment. *Journal of the American Planning Association* 76:265–294.

Kramer, M. 2013. Our built and natural environments: A technical review of the interactions among land use, transportation, and environmental quality, Second edition. Environmental Protection Agency, Washington, D.C.

Fan, Y., and A. J. Khattak. 2008. Urban form, individual spatial footprints, and travel: Examination of space-use behavior. *Transportation Research Record* 2082:98–106.